108 - CONTROL STRATEGIES IN INTERCEPTIVE TASKS SIMULATED IN VIRTUAL ENVIRONMENT

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INTRODUCTION

Interceptive tasks are present in sports and in several daily tasks (VELDE at al., 2005). The capacity of perceiving changes in environment is essential for planning and implementing motor actions, especially in these interceptive skills (BRENNER; SMEETS, 2009; MAZYN et al., 2007). Such skills involve great integration between sensorial and motor systems, in which visual system is one of the main responsible for providing continuous information about the environment and about the body position (SCHMIDT; WRISBERG, 2001). Thus, the vision is essential, mainly, when it involves the synchronization between an objects displacement and a body segment movement (VELDE at al., 2005; ANDRADE et al., 2005).

The visual information allows the recognition of a pattern and an anticipation for the interception of and object being moving. Such actions occur based on an internal model that would be built considering previous experiences (BROWER et al., 2005; AZEVEDO NETO et al., 2009; TEIXEIRA et al., 2006a). Thus, practice would provide adjustments in the parameters of this internal model (TEIXEIRA et al., 2006b), while the visual information would be used indirectly to estimate the target arrival. At least three different motor control strategies can be highlighted for the performance of the interceptive motor skills, named as: pre-programming, programming and re-programming (PORT et al., 1997).

The pre-programming is the choice of the generalized motor program and the control parameters before the beginning of the interceptive action. In other words, the pattern recognition (based on the internal model) and the anticipation occur in this strategy. The programming is different because it can be performed only after an imperative stimulus for the action choice. While, in reprogramming, there is a sudden and unexpected change in the behavior of the object to be intercepted that demands new movement programming (TEIXEIRA; FRANZONI, 2006; AZEVEDO NETO, 2009; TEIXEIRA et al., 2005). Such unexpected changes require movement reprogramming, with spatial-temporal changes (TEIXEIRA; FRANZONI, 2006). These changes demand more time to process information (TEIXEIRA; FRANZONI, 2006). Consequently, it would be expected worse performance for the reprogramming control strategy, in comparison to the other strategies of control. Indeed, there would be an advantage for pre-programming strategy, because this strategy allows the possibility of specifying movement details before its performance. However, the performance comparison between these different motor control strategies has not been focus of study.

In the light of the above, it was compared the performance of the pre-programming, programming, and reprogramming strategies of motor control in an interceptive skill simulated in virtual environment. The present study has the potential of analyzing the effect that the use of different motor control strategy in interceptive tasks has on performance.

METHODS

Sample

The experiment was performed in GEPEDAM laboratory at Londrina State University, with nine participants (age M= 27,7 years old, DP= 6,15), in which eight were right handed and one left-handed. All participants were normal or corrected vision (using glasses). After research instructions, participants assigned a free and clarify consent form.

Equipment and task

Task consisted in pressing a button at the instant in which a moving object arrived at the end of a track in a virtual environment. The performance of the interceptive task was analyzed with the use of notebooks (equal or above to the Dual Core processors, 1 GB of memory, from ACER, CCE, Toshiba and HP brands) and the Interception Task software (OKAZAKI, 2008). The software reproduced a red rectangular target (2,3 cm x 1 cm) that was moved a long a straight track demarked (19,7 cm x 3 cm), in horizontal direction and with movement performed from the left to the right side. The target displacement characteristics (speed) were manipulated by the software. To simulate the pre-programming condition (PRE) a set of trials were used with constant speed. Therefore, it allowed an adaptation to the participant to estimate, before the beginning of the movement, the motor program and the specific control parameters for the task. The programming condition (PRO) was performed through three different constant velocities randomized by the software. Therefore, the participant would always need to wait until the target start moving to be allowed to perform the selection and programming response. For the reprogramming (REP) condition it was used repetitions of the constant velocity (probability of 80%) and a random velocity (probability of 20%), with the velocity increasing in the middle of the track. The temporal accuracy in this task was measured by the difference between the target arrival at the final track portion and the participant response time (pressing the mouse button on a computer).

PROCEDURES

Participants were informed about the correct body postures, right in front of the computer, as well as the research procedures and aims. Twenty trials were performed as a familiarization to stabilize the performance. For data collection, it was performed a set of trials until, at least, five specific trials in the intermediate velocity (V2) were performed. The participants received visual feedback (knowledge of results) about the temporal errors for each trial.

The trials of the experimental phase were separated by blocks, pseudo-aleatorized between the participants. The pre-programming condition was performed with constant velocity of the target with V1=14,2 cm/s. The programming condition was performed with three constant velocities randomized by the software, with magnitudes of V1=21,3 cm/s, V2=14,2 cm/s and, V3=10,6 cm/s. While, in the reprogramming condition it was used the velocity V1= 14,2 cm/s (probability of 80%) and the velocity increasing in the middle of the track with a mean velocity of V2= 20,6 cm/s. During the programming and reprogramming only the trials with V1=14,2 cm/s were used for the analysis. The quantification of the absolute error, obtained during the data collection, was normalized in function of the task time.

Statistical Analysis

The performance was analyzed by the temporal errors (difference between the time of the target arrival and the effective action of pressing a button). It were calculated the absolute, quadrate, variable, and constant error. The comparison between conditions was performed by the ANOVA test with repeated measures, followed by the Bonferroni test. Significance was set at 5% ($P<0,05$).

RESULTS

The absolute ($F_{2,16}$= 1,493; P= 0,254), square ($F_{1,9}$= 0,833; P=0,4), and variable ($F_{1,8}$= 0,875; P= 0,381) error, did not show difference between the strategies of control used. The constant error indicated significant effect ($F_{2,16}$= 11,754; P= 0,001), in which there was greater error in the reprogramming condition in comparison to pre-programming (P= 0,004) and programming (P= 0,019) conditions. It was verified, in the pre-programming and programming conditions, a error directional tendency for anticipated responses (M= -0,00135 s, M= -0,0039 s, respectively to PRE and PRO), while, during reprogramming condition, the predominant error direction tendency were the delayed responses (M= 0,0105). Figure 1 shows the mean and standard deviations for the performance of each error calculated.

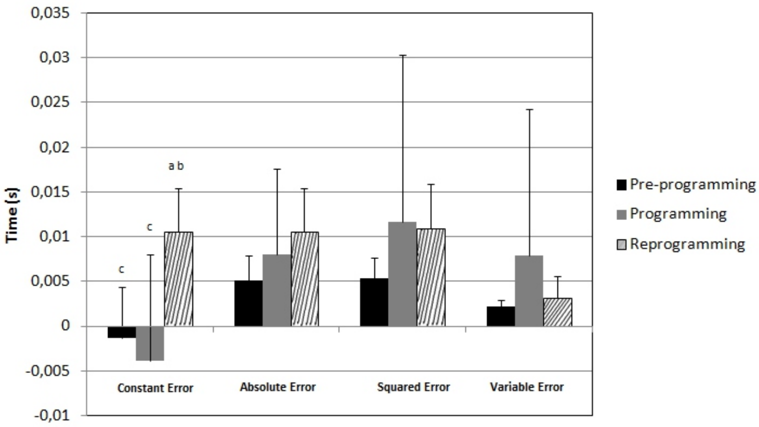

Figure 1. Mean and standard deviation for the temporal errors (s) (constant, absolute, square, and variable errors), in the pre-programming, programming and reprogramming conditions. Significant differences (P<0,05) in comparison to apreprogramming, bprogramming, and creprogramming.

DISCUSSION

This study compared the performance of the pre-programming, programming, and reprogramming strategies, in the control of the interceptive motor skill simulated in virtual environment. It was hypothesized that pre-programming would show better performance than programming and reprogramming conditions, because it would allow the specification of the movement details before its performance. While, programming condition would perform better performance than reprogramming, because reprogramming condition would need greater temporal demand for the movement organization (TEIXEIRA; FRANZONI, 2006).

Considering the analysis of the absolute error, the reprogramming condition showed greater temporal error in comparison to pre-programming and programming conditions. Thereby, the results verified in the present study corroborates with the studies of other authors that also verified greater error in the reprogramming condition in comparison to pre-programming condition (LEE et al., 1997; AZEVEDO NETO; TEIXEIRA, 2006b). According to Teixeira and Franzoni (2006), the condition with less uncertainty leads to better performance, providing temporally more accurate response, mainly, in these situations with velocity change (TEIXEIRA; FARNZONI, 2006). The initial visual information is essential for the performance of the interceptive motor skills, and may be a factor that influences the process of response delays in situations with velocity changes (BENNETT et al., 2010; TEIXEIRA et al., 2006a.; BOCK; JUNGLING, 1999; BRENNER; SMEETS, 1997; 2004; 2009). Such difference between the reprogramming strategies, in comparison to the other conditions (pre-programming and programming), is more evident in function of the aging process (TEIXEIRA et al., 2006b).

In spite of the difference verified in the constant error between the control strategies used, it was not verified differences for the other measures of error. This lack of effect in the different control strategies in the interceptive task (absolute, square, and variable errors) was explained by a study limitation. As there were only nine participants in the study, we observed a large standard deviation in the responses (specially in programming condition). Possibly, increasing the number of participants in the sample, it would be verified differences for the other errors variables used in the study. Even with this limitation of a small sample , the present study used the simulation in a virtual environment, allowing greater control of experimental conditions. Several authors have used similar methods, because this method ensures greater reliability for the simulation and analysis of the different motor control strategies (BOCK; JUNGLING, 1999; TEIXEIRA; FRANZONI; BRENNER; SMEETS, 2009).

CONCLUSION

The pre-programming strategy showed advantage in the performance in comparison to programming and reprograming strategies of control. This advantage was explained by the possibility of specifying the movement control parameters in an anticipated manner. The reprogramming strategy showed inferior performance in comparison to the other control strategies analyzed. Such result was explained by the greater time need for the information processing (responses identification, selection, and programming) to readapt the motor response. It was suggested new studies with the analysis of different strategies of control for motor skills in sports, such as: tennis, table tennis, volleyball, etc.

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CONTROL STRATEGIES FOR INTERCEPTIVE TASKS SIMULATED IN VIRTUAL ENVIRONMENT

ABSTRACT

The present study compared the performance, in an interceptive task, in function of different motor control strategies (pre-programming, programming and reprogramming). Nine participants (mean, 27 years old) performed the task of pressing a button as soon as an object in movement reached the end of its trajectory in a virtual environment. For pre-programming it was used a constant velocity, for programming three different constant velocities, and for reprogramming repetitions of the constant velocity (probability of 80%) and random velocity (probability of 20%) with increase in the velocity during the half of the track. It were analyzed the constant, absolute, quadratic, and variable error. The results for constant error indicated significant effect ($F_{2,16}$= 11,75; P= 0,001), in which there was greater error in reprogramming in comparison to pre-programming (P= 0,004) and programming (P= 0,019). It was not found differences for the absolute ($F_{2,16}$= 1,493; P=0,254), square ($F_{1,9}$= 0,833; P= 0,400), and variable ($F_{1,8}$= 0,875; P= 0,381) errors. In preprogramming and programming response directional tendency was anticipated, while in reprogramming the responses were delayed. The advantage in preprogramming was due to specification of the movement control parameters in advance. The reprogramming may be explained by the longer time required in the stages of information processing (response identification, selection, and programming) to readjust the response.

KEY-WORDS: control strategies, interception, information processing.

CONTRÔLEZ DES STRATÉGIES POUR TÂCHES INTERCEPTIVE SIMULÉES DANS ENVIRONNEMENT VIRTUE

RÉSUMÉ

Cette étude a comparé la performance sur la tâche d'intercepter une fonction de différentes stratégies de contrôle moteur (pré-programmation, programmation et la reprogrammation). À cette fin, neuf participants (moyenne 27 ans) a effectué la tâche d'appuyer sur un bouton dès que l'objet en mouvement atteint la fin de sa trajectoire dans un environnement virtuel. Dans la programmation pré-a été utilisé une vitesse constante, vitesse constante en trois programmes différents, et une reprogrammation de la vitesse constante de répétitions (80% de probabilité) et la vélocité aléatoire (20% de probabilité) avec une vitesse accrue dans le milieu du chemin. Nous avons analysé l'erreur constante, absolue, et quadratique variable. Les résultats de l'erreur constante indiquée significative ($F_{2,16}$= 11,75, P= 0,001), dans lequel il n'y avait plus d'erreur dans la reprogrammation par rapport aux pré-programme (P= 0,004) et la programmation (P= 0,019). Il n'y avait aucune différence dans les erreurs absolues ($F_{2,16}$= 1,493 P= 0,254), quadratique ($F_{1,9}$= 0,833 P= 0,400) et variables ($F_{1,8}$= 0,875 P= 0,381). Dans les réponses pré-programmation et la programmation tendance directionnelle a été prévu, alors que dans la reprogrammation des réponses ont été retardées. L'avantage de pré-programmation est due à des spécifications des paramètres de contrôle des mouvements à l'avance. Reprogrammation peut être expliquée par le temps plus long nécessaire dans les

étapes de traitement de l'information (identification, la sélection et la programmation de la réponse) pour réajuster la réponse.

MOTS-CLÉS: stratégies de contrôle, l'interception, le traitement de l'information.

ESTRATÉGIAS DE CONTROL EN TAREA DE INTERCEPTACIÓN SIMULADA EN AMBIENTE VIRTUAL

RESUMEN

Este estudio comparó el desempeño en tarea de interceptación, en función de diferentes estrategias de control motor. Nueve participantes (media de 27 años) realizaron la tarea de accionar un botón después de que un objeto en desplazamiento llegase al final de la trayectoria recorrida en el ambiente virtual. Para la pre-programación se utilizó una velocidad constante, en la programación tres velocidades constantes distintas y en la reprogramación, repeticiones de la velocidad constante (80% de probabilidad) y velocidad aleatoria (20% de probabilidad) con aumento en el medio de la trayectoria. Se analizaron los errores constante, absoluto, cuadrático y variable. Los resultados para el error constante indicaron efecto significativo (F2,16= 11,75; P= 0,001), se demostró mayor error en la reprogramación de que en la pre-programación (P= 0,004) y programación (P= 0,019), así mismo para los errores absoluto (F2,16= 1,493 P= 0,254), cuadrático (F1,9= 0,833 P= 0,400) y variable (F1,8= 0,875 P= 0,381) no hubo diferencias. En la pre-programación y programación la tendencia direccional fue de repuestas anticipadas, así mismo, en la reprogramación fue de respuestas atrasadas. La ventaja en la pré-programación ocurrió en función de las especificaciones de los parámetros de control en el movimiento anticipadamente. La reprogramación puede ser explicada por el mayor tiempo necesario en las etapas de procesamiento de información (identificación, selección y programación) para readecuar la respuesta.

PALABRAS LLAVE: estrategias de control, interceptación, procesamiento de informaciones.

ESTRATÉGIAS DE CONTROLE EM TAREFA INTERCEPTATIVA SIMULADA EM AMBIENTE VIRTUAL

RESUMO

Este estudo comparou o desempenho, em tarefa de interceptação, em função de diferentes estratégias de controle motor (pré-programação, programação e reprogramação). Para tanto, nove participantes (média de 27 anos) realizaram a tarefa de acionar um botão logo que um objeto em deslocamento chegasse ao final de sua trajetória percorrida em ambiente virtual. Na pré-programação foi utilizada uma velocidade constante, na programação três velocidades constantes distintas, e na reprogramação repetições da velocidade constante (80% de probabilidade) e velocidade aleatória (20% de probabilidade) com aumentado da velocidade no meio da trajetória. Foram analisados os erros constante, absoluto, quadrático e variável. Os resultados para o erro constante indicaram efeito significante (F2,16= 11,75; P= 0,001), em que houve maior erro na reprogramação em comparação à pré-programação (P= 0,004) e à programação (P= 0,019). Não foi verificada diferença para os erros absoluto (F2,16= 1,493 P= 0,254), quadrático (F1,9= 0,833 P= 0,400) e variável (F1,8= 0,875 P= 0,381). Na pré-programação e programação a tendência direcional foi de respostas antecipadas, enquanto na reprogramação as respostas foram atrasadas. A vantagem na pré-programação ocorreu em função das especificações dos parâmetros de controle no movimento antecipadamente. A reprogramação pode ser explicada pelo maior tempo necessário nos estágios de processamento de informação (identificação, seleção e programação da resposta) para readequar a resposta.

PALAVRAS-CHAVE: estratégias de controle, interceptação, processamento de informações.